Low-Intensity Swimming Training
does not Improve Hypertension in Rats

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Abstract

**Aim:** To investigate the effects of low-intensity swimming training upon arterial blood pressure in 26-weeks-old male spontaneously hypertensive rats.

**Methods:** The animals were randomly divided into two groups: sedentary (SED, n = 7) and trained (TR, n = 7). The aerobic training consisted of 90-min swimming sessions, five days a week. After nine weeks of intervention, the arterial blood pressure and heart rate were invasively measured using a catheter inserted into the femoral artery.

**Results:** No significant differences were observed between groups for systolic arterial blood pressure (TR: 202.87 ± 3.29 vs. SED: 203.11 ± 6.13 mmHg, p = 0.48, ES = -0.01), diastolic arterial blood pressure (TR: 141.79 ± 2.76 vs. SED: 142.50 ± 4.54 mmHg, p = 0.45, ES = -0.05), mean arterial blood pressure (TR: 170.80 ± 2.83 vs. SED: 171.76 ± 5.23 mmHg, p = 0.44, ES = -0.06), and heart rate (TR: 310.42 ± 10.79 vs. SED: 328.50 ± 12.41 beats.min⁻¹, p = 0.16, ES = -0.50).

**Conclusion:** The present study demonstrated that low-intensity swimming training cannot improve arterial blood pressure in an experimental model of severe hypertension.

**Keywords:** exercise, swimming training, spontaneously hypertensive rats

**Introduction**

It is well known that aerobic training may prevent and treat cardiovascular diseases by yielding beneficial adaptations on heart morphology and hemodynamic parameters [1-3]. Not surprisingly, aerobic training has been considered as the most important non-pharmacological strategy in the treatment of arterial hypertension. However, the ideal exercise training program for attenuating arterial blood pressure remains not fully elucidated.
Several studies have examined different protocols of exercise training on hypertension by using spontaneously hypertensive rats (SHR), which is a well-accepted genetic model of hypertension [4]. Taken together, these studies suggest the beneficial effects of aerobic training upon arterial blood pressure seem to be exercise intensity-dependent [1,5-7]. For instance, Verás-Silva et al. [5] reported reductions in arterial hypertension after a low-intensity, but not high-intensity aerobic training program in 4-weeks-old SHR. Further studies were able to replicate the beneficial effects of low-intensity aerobic training on arterial blood pressure in 16-weeks-old [1] and 6-weeks-old SHR [7]. Nonetheless, it is known that arterial SHR blood pressure peaks at 24 weeks of age [4]. To our knowledge, only Emter et al. [6] studied the effects of treadmill exercise training in old SHR. The authors observed attenuation in arterial blood pressure, which was followed by delayed onset of decompensated heart failure. To date, no study has examined the effects of swimming training in old SHR.

It has been postulated that swimming training may differently affect arterial blood pressure, since this training mode differs from running training with respect to body position in the water, water pressure and temperature regulation [8]. Therefore, the present study aimed to investigate the effects of low-intensity swimming training upon arterial blood pressure in 26-weeks-old SHR.

Material and Methods

Sample and Procedures

Fourteen 26-weeks-old male SHR were housed (3-4 animals per cage) under controlled environmental conditions (22°C; 12:12-h light:dark period) with free access to commercial chow and water. Animals were randomly divided into two groups: sedentary (SED; n = 7) and trained (TR; n = 7). During nine weeks, the TR group was submitted to an aerobic training program previous characterized as a low-intensity and long-duration training [2]. Forty-eight hours after the intervention, arterial blood pressure and heart rate were invasively measured using a catheter inserted into the femoral artery.

This study was approved by the institution’s ethical committee and was conducted in accordance with the National Research Council’s Guidelines for the Care and Use of Laboratory Animals.
Aerobic training protocol

The aerobic training consisted of 90-min swimming sessions for 5 days a week in an apparatus adapted for rats containing warmed water (30-32°C). Exercise duration was increased gradually until the rats could swim for 90 min. Sedentary animals were placed in the swimming apparatus for 10-min twice a week to mimic the water stress associated with the experimental protocol [8].

Arterial blood pressure and heart rate

After an intra-peritoneal anesthetic injection (80 mg/kg ketamine and 12 mg/kg xylazine, i.p.), a catheter filled with 0.06 mL of saline was inserted into the femoral artery of rats. Twenty four hours after the catheter insertion, the arterial cannula was connected to a strain-gauge transducer (Blood Pressure XDCR; Kent Scientific, Torrington, CT, USA), and arterial pressure signals were recorded over a 30 min period in conscious rats by a microcomputer equipped with an analog-to-digital converter board (WinDaq, 2 kHz, DATAQ, Springfield, OH, USA). The recorded data were analyzed on a beat-to-beat basis to quantify systolic, diastolic and mean arterial pressure, as well as the heart rate.

Statistical Analysis

Data are expressed as mean ± standard error. The hemodynamic parameters were tested by unpaired Student’s T test. Effect size was calculated for all variables. The level of significance was previously set at p < 0.05.

Results

No significant differences were found between groups for systolic blood pressure, diastolic blood pressure, mean blood pressure, and heart rate (Table 1).

Discussion

This study aimed to assess the effects of a low-intensity swimming training program upon arterial blood pressure in 26-weeks-old SHR. No beneficial
effects were noticed, suggesting that the beneficial effects of this mode of training are limited (if any) in severe arterial hypertension.

In fact, several [1, 5-7], but not all [2] studies have been showed that a low-intensity aerobic training can attenuate arterial hypertension in adult SHR. However, studies with old SHR, with severe hypertension are still scarce. In this respect, Emter et al. [6] were able to show important improvements in arterial blood pressure in old SHR following a treadmill low-intensity aerobic training program. Nonetheless, swimming training may differ from running training in terms of body position in the water, water pressure and temperature regulation [8], possibly leading to discrepant arterial blood pressure responses. It is possible that the training mode applied in our study versus that in Emter’s study can partially explain the conflicting results.

Moreover, one cannot rule out the possible influence of exercise intensity on arterial blood pressure response, particularly in elderly. Supporting this notion, a human study [9] demonstrated similar hypotension response to an aerobic exercise session in young normotensive males, irrespective of the intensity (i.e. 30%, 50% and 80% of VO$_2$ peak). In contrast, older hypertensive males presented a greater post-exercise reduction in arterial blood pressure after 70% of VO$_2$ peak than 50% of VO$_2$ peak [10]. This human study, along with the current experimental one, suggests that low-intensity aerobic training may be insufficient to attenuate hypertension. Further studies should examine the role of exercise intensity and mode on arterial blood pressure in long-term severe hypertension.

In summary, the present study did not demonstrate any beneficial effects of low-intensity swimming training on arterial blood pressure in an experimental model of severe hypertension.

Acknowledgments

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References


Table 1. Arterial blood pressure and heart rate response in sedentary and trained SHR

<table>
<thead>
<tr>
<th></th>
<th>Sedentary SHR</th>
<th>Trained SHR</th>
<th>p value</th>
<th>ES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mmHg)</td>
<td>203.11 ± 6.13</td>
<td>202.87 ± 3.29</td>
<td>0.48</td>
<td>-0.01</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>142.50 ± 4.54</td>
<td>141.79 ± 2.76</td>
<td>0.45</td>
<td>-0.05</td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>171.76 ± 5.23</td>
<td>170.80 ± 2.83</td>
<td>0.44</td>
<td>-0.06</td>
</tr>
<tr>
<td>HR (beats.min⁻¹)</td>
<td>328.50 ± 12.41</td>
<td>310.42 ± 10.79</td>
<td>0.16</td>
<td>-0.50</td>
</tr>
</tbody>
</table>

No significant differences were found between groups for any parameter. Abbreviations: SHR = spontaneously hypertensive rats; ES = effect size; SBP = systolic blood pressure; DBP = diastolic blood pressure; MBP = mean blood pressure; and HR = heart rate

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